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INFORMATION ON INTERNATIONAL GEOPHYSICAL COOPERATION -- SOVIET-BLOC ACTIVITIES

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The principal features of the apparatus used for observing the artificial comets and the results of observations made of the 12 September 1959 sodium cloud ejected by the second Soviet cosmic rocket which hit the Moon are given. Some properties of the expanding sodium cloud are described. Possible ways of further developing the method are mentioned. ("Artificial Comet," by I. S. Shlovksiy, V. F. Yesipov, V. G. Kurt, V. I. Moroz, and P. V. Shcheglov, State Astronomical Institute imeni P. K. Shternberg; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 59, pp 1073-1077).

Perturbations in Satellite Motion

The problem on the analytical determination of secular perturbations in the theory of motion of an artificial earth satellite in the first approximation, taking into account the flattening of the Earth and the resistance of the atmosphere, is considered in an article by Ye. A. Grebenikov, State Astronomical Institute imeni P. K. Shternberg. The model of the atmosphere proposed by D. Ye. Okhotsimskiy, and others, was used for deriving the secular perturbations caused by air resistance. The secular perturbations of the elements of the orbit of the American satellite β_2 from the obtained formulas. ("On the Secular Perturbations in the Theory of Motion of Artificial Earth Satellites," by Ye. A. Grebenikov; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 59, pp 1111-1121)

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II. UPPER ATMOSPHERE

Three "Velocities" of Corpuscular Streams

By comparing the effect of chromospheric flares with geomagnetic activity we have determined the existence of three maxima of disturbance following the moment of the passage of a solar active region across the Sun's central meridian. Figure 1 (Figures are not reproduced here) is a graph of the mean daily K-indices, derived by the method of superimposition of epochs for 1957-1958 by comparison with the effect of flares.

This work is an attempt at an independent confirmation of the existence of the three sequences of maxima and determination of the probability of alternation of geomagnetic disturbances in time. The presence of the indicated maxima may be confirmed by examining the sequences of K-indices over a more or less prolonged interval of time. The use of the method of superimposition of epochs in the form in which it is usually used for the discovery of a 27-day cycle, does not prove effective in this case. In actuality, the zero-day can correspond to a maximum of type I, II or III in the method of superimposition of epochs because it is only selected by the criterion of the presence of heightened activity on a given day. After a zero-day and before a zero-day corresponding to a maximum of type I, II or III, with approximately equal probability there will be increases in activity on the 8th, 11th, 16th and 19th days. Table 1 gives the days of the expected increase in activity before and after the corresponding maxima.

TABLE 1

Day Before Maximum	Type of Maximum	Day After Maximum
27 19 8	I	8 19 27
27 16 8	II	11 19 27
27 19 11	III	8 16 27

Thus, if the zero-day corresponds to a maximum of type I, it is possible to assume an increase in activity on the 8th and then on the 19th and 27th days after the zero-day and on the 8th, 19th and 27th days before the zero-day, etc.

In the method of superimposition of epochs, when any one of the maxima is used for the zero-day, there evidently occurs a "smoothing out" of adjoining disturbances, and, depending on the value of each of them, there is an insignificant increase near one day or the other. When there is a great deal of statistical data the effect disappears entirely and on the composite curve there only remains the well known 27-day cycle (Kr: /Russian transliteration/ diagram). Similar reasoning is possible in respect to the days of low activity.

However, as follows from Table 1, in accordance with our hypothesis of the existence of three kinds of maxima, there is a possibility of dividing up the sequences with the zero-days corresponding to maxima of types II and III. In actuality, in sequences with maxima of type II the disturbances are expected on the 11th day after the zero-day and simultaneously on the 8th day before the zero-day, whereas in maxima of type III on the 8th day following disturbances and on the 11th day preceding. If we distinguish a sequence having high activity on the 8th day after the zero-day (in the right part of the sequence), then we can anticipate it will shown the appearance of a minimum on the 8th and a maximum on the 11th day before the zero-day (in the left part). It seems possible to numerically determine the probability of this event as $P_1 = m_1/N_1$ (where N_1 -- the number of sequences satisfying the condition $A_8 > A_{11}$; m_1 -- the number of sequences from N_1, simultaneously satisfying the condition $A_{-5} > A_{-8}$, $A_{-8} \angle A_{-11}$, $> A_{-11}$ A_{-14}. In a similar manner it is possible to determine the probability of the appearance of other combinations of inequalities. Simultaneously there is the possibility of computing the probability of the appearance of combinations of these same inequalities in the left part for sequences satisfying in the right part the equation $A_8 \angle A_{11}$. Thus, when the sequences are broken down into groups by sign to the right of the zero-day, the tendency for the appearance in them of certain extremes is present to the left of the zero day. It should be noted that in a random distribution of disturbances the right and left parts of sequences are apparently independent.

We have 1,625 sequences of mean daily values for K_p-indices for a 13-year period (1946-1958). Following the zero-day in each sequence we selected the most disturbed days, equal to 10-11 days each month. To the right and to the left of the zero-day the diurnal characteristics have been given which correspond to the days following and preceding. We have excluded from examination sequences satisfied by the condition $A_n = A_n \angle 3$ ($n =$ 5; 8; 11).

Table 2 gives the probability of appearance of these combinations of inequalities: $P_1 = m_1/N_1$ for the left parts of sequences satisfying in the right part the condition A_8 A_{11}; $P_2 = m_2/N_2$ for the left parts of the sequences satisfying the condition $A_8 > A_{11}$; $P = \frac{m_1 \angle m_2}{N_1 \angle N_2}$ for the left parts of the sequences, without division into groups. In a similar way we investigated these same sequences applying to conditions in the left part (before the zero-day) and determining the frequency of appearance of the determined combinations of inequalities in the right part (after the zero-day) (Table 2): $P_1 = m_1/N_1$ for sequences with the conditions $A_{-8} > A_{-11}$ and $P_2 = m_2/N_2$ with the condition that $A_{-8} \angle A_{-11}$.

Conclusions

An analysis of the data received indicates the following:

1. In sequences having increased disturbance for 8 days before or after the zero-day, one notes a tendency to a maximum on the 11th day and a minimum on the 8th day after (or corresponding to) the zero-day.

2. In sequences having increased disturbance for 11 days before (or after) the zero-day, one notes a tendency to a maximum on the 8th day and a minimum on the 11th day after (or corresponding to) the zero-day.

3. The probability of the indicated alternations of activity are considerably higher than with a random (P_0 = 0.125) distribution of alternations.

4. The assumption of three maxima finds in this fact still another confirmation and it should be borne in mind that the investigated interval of time embraces periods of rise and fall in the 11-year solar cycle. The indicated conclusions are confirmed in any of the 13 investigated years (1946-1958).

The delimitation of sequences with the above-indicated probability apparently enables us to distinguish definite disturbances corresponding to the different "velocities" of corpuscular streams.

TABLE 2

LEFT PARTS OF SEQUENCES

	A_{-5} A_{-8}	A_{-5} A_{-8}	A_{-8} A_{-11}	A_{-8} A_{-11}	A_{-11} A_{-14}	A_{-11} A_{-14}
P	0.51	0.49	0.50	0.50	0.52	0.48
P_1	0.49	0.51	0.53	0.47	0.45	0.55
P_2	0.54	0.46	0.48	0.52	0.59	0.41

	A_{-5} A_{-8} A_{-8} A_{-11}	A_{-5} A_{-8} A_{-8} A_{-11}	A_{-5} A_{-8} A_{-8} A_{-11}	A_{-5} A_{-8} A_{-8} A_{-11}	A_{-8} A_{-11} A_{-11} A_{-14}	A_{-8} A_{-11} A_{-11} A_{-14}
P	0.32	0.31	0.20	0.17	0.31	0.32
P_1	0.30	0.34	0.19	0.17	0.35	0.28
P_2	0.35	0.29	0.19	0.17	0.26	0.36

	A_{-8} A_{-11} A_{-11} A_{-14}	A_{-8} A_{-11} A_{-11} A_{-14}
P	0.20	0.17
P_1	0.18	0.19
P_2	0.21	0.15

	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}	A_{-5} A_{-8} A_{-8} A_{-11} A_{-11} A_{-14}
P	0.05	0.14	0.21	0.11	0.14	0.18
P_1	0.05	0.14	0.18	0.12	0.12	0.22
P_2	0.05	0.13	0.25	0.11	0.16	0.13

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	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}
P	0.13	0.04
P_1	0.12	0.05
P_2	0.13	0.04

RIGHT PARTS OF SEQUENCES

	A_5 A_8	A_5 A_8	A_8 A_{11}	A_8 A_{11}	A_{11} A_{14}	A_{11} A_{14}
P	0.48	0.52	0.48	0.52	0.50	0.50
P_1	0.44	0.56	0.52	0.48	0.47	0.53
P_2	0.51	0.49	0.46	0.54	0.52	0.48

	A_5 A_8 / A_8 A_{11}	A_5 A_8 / A_8 A_{11}	A_5 A_8 / A_8 A_{11}	A_5 A_8 / A_8 A_{11}	A_8 A_{11} / A_{11} A_{14}	A_8 A_{11} / A_{11} A_{14}	A_8 A_{11} / A_{11} A_{14}	A_8 A_{11} / A_{11} A_{14}
P	0.31	0.33	0.15	0.21	0.31	0.33	0.17	0.19
P_1	0.28	0.37	0.15	0.20	0.35	0.29	0.17	0.19
P_2	0.36	0.29	0.15	0.20	0.27	0.36	0.17	0.20

	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}	A_5 A_8 A_{11} / A_8 A_{11} A_{14}
P	0.04	0.11	0.19	0.14	0.12	0.20	0.14	0.06
P_1	0.04	0.12	0.16	0.13	0.12	0.23	0.14	0.06
P_2	0.04	0.11	0.22	0.14	0.13	0.16	0.14	0.06

("The Problem of Three 'Velocities' of Corpuscular Streams", by G. M. Barsukov, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 155-157).

Study on Continuous Solar Emission in the X-Ray Region

An exact knowledge of the spectrum of X-ray emission of the Sun is of considerable astrophysical and geophysical interest. It is important for the precise determination of the temperature of the solar corona as well as for a true estimate of the action of solar coronal emission in the upper layers of the Earth's atmosphere. All of these problems are of recent origin and have received only a preliminary solution. Certain new considerations of the Sun's continuous X-ray emission are made by T.V. Kazachevskaya and G. S. Ivanov-Kholodnyy in an article in the November-December issue of the Soviet scientific publication Astronomicheskiy Zhurnal.

The authors, in their article, have computed the Gaunt factor and calculated the continuous emission spectrum of the solar corona. On the basis of X-radiation and also from the ratio of X-radiation and radio emission it was determined that $T \cong 1.5 \cdot 10^6$ degrees K. The energy of the continuous emission of the Sun near the Earth beyond Lyman limit is > 0.3 ergs/cm^2 sec. It is shown that the solar corona is extremely inhomogeneous its material being concentrated mainly in specific formations which occupy approximately 1/100th part of its entire volume. ("On the Continuous Solar Emission in the X-ray region of the Spectrum," by T. V. Kazachevskaya and G. S. Ivanov-Kholodnyy, Institute of Applied Geophysics, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 59, pp 1022-1027).

Study of Solar Corpuscular Streams Based on IGY Data

An examination of copies of magnetograms kept at World Data Center B-2, Moscow, made by M. S. Bobrov, Astronomical Council, Academy of Sciences USSR, showed that according to the type of geomagnetic disturbance, the whole globe can be divided into the following sharply-differing belts: a) A belt of symphase disturbances ($|\Phi| \gtrsim 50°$), characterized by the presence of wide regions (10,000 km and over) where the horizontal intensity varies almost synchronously over periods of many hours, is typical of this belt. The large dimensions of these regions indicate that the sources of the disturbances are distant from the Earth's surface (one or more earth radii); b) two belts of local disturbances (from $\Phi \sim 50°$ to the outer edge of the nearest polar cap) characterized by the absence of synchronism of disturbance at distances between observatories of several hundred kilometers and over. The sources of these disturbances are near the Earth, are small in size, and are localized mainly in the night sectors of the auroral zones; and c) two belts of almost continuous disturbances (the northern and southern polar caps) characterized by almost a complete absence of magnetically quiet days and day maximum activity. As a rule, the disturbances are local, although traces of symphase disturbance are sometimes observed.

The existence of the belts of geomagnetic disturbances can be explained by the following working hypothesis of the interaction of a solar corpuscular stream and the Earth. During the period of a synphase disturbance (a typical duration is about 1-3 hours) the Earth passes through a large ($\sim 3 \cdot 10^6 - 1 \cdot 10^7$ km) condensation of solar plasma. The geomagnetic field prevents the condensation matter from approaching the earth's surface nearer than one or several earth radii. The deformations of the geomagnetic field which arise from this cause synphase disturbances. Small scraps of plasma tear from the condensation, penetrate the upper atmosphere over the auroral zone along Stoermer trajectories, and cause local disturbances. Over the belts of permanent disturbances the geometry of th geomagnetic field is such that the capture of matter moving past the Earth is possible. It is thus possible to explain the existence in these belts of the almost continuous background of disturbances even on magnetically-quiet days.

The irregularity of the synphase disturbances with time are the direct result of the inhomogeneous structure of the solar corpuscular streams. The study of these disturbances may be a good means for investigating the fine structure of these streams. ("Study of Solar Corpuscular Streams on the Basis of World-Wide Geomagnetic Disturbances Observed during the IGY," by M. S. Bobrov, Astronomical Council, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 59, pp 1028-1036).

Spectroscopic Study of the Lunar Surface

The results of a spectrophotometric study of 90 areas of the lunar surface made by V. G. Teyfel', Sector of Astrobotany, Academy of Sciences, Kazakh SSR, are presented in an article in Astronomicheskiy Zhurnal. Spectral curves for these areas, constructed relative to a reference area in the Mare Vaporum, are characterized by an almost monotonous change in intensity along the spectrum. This makes it possible to use the color indices for mass estimates of the color of lunar objects. The maximum difference in the spectral curves, expressed in relative spectrophotometric gradients, is 0.57 for 390-500 mu and 0.72 for 510-620 mu, i.e. it does not exceed 0.6 of the spectral class dG. ("On Differences in the Spectral Properties of Areas of the Lunar Surface," by V. G. Teyfel', Sector of Astrobotany, Academy of Sciences Kazakh SSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, pp 1041-1045).

New Camera for Lunar Observations At Pulkovo

The main details in calculating the design of a Markovits camera which is being used with the standard astrograph (D 345 mm, F 3450 mm) at the Main Astronomical Observatory at Pulkovo, are given in an article by Kh. I. Potter and Yu. S. Streletskiy. The camera, produced by the observatory's optical-mechanical shop was put into operation in May 1957. A description of the camera is also given. Use of the camera during 1957-1958, revealed its high quality and its ease of handling and reliability in operation. ("Camera for Observations of the Moon with the Standard Astrograph of the Main Astronomical Observatory of the Academy of Sciences USSR at Pulkovo," by Kh. I. Potter and Yu. S. Streletskiy, Main Astronomical Observatory, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 1959, pp 1047-1052).

Proposed Method for Determining Space Coordinates of a Meteor

An explanation of the principles and a description of the method for using stereophotogrammetric instruments in meteor astronomy are contained in an article by N. D. Rozenblyum, All Union Astronomical-Geodetical Society, which appeared in a recent issue of the Soviet scientific periodical Astronomicheskiy Zhurnal. In comparison with the "classical" method, the proposed means gives considerable simplification and acceleration in the processing of photographs taken at two stations. The results obtained are identical.

In the present study, the stereophotogrammetric method was applied to the photography of meteors at zenith. However, it can also be used in the case of a general survey. ("Application of a Photogrammetric Method for Determining the Space Coordinates of the Trajectory of a Meteor," by N. D. Rozenblyum; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 6, Nov-Dec 59, pp 1061-1073).

III METEOROLOGY

Relationship Between Turbulency and Height in the Near-Surface Layer of the Atmosphere

About 30 years ago B. I. Izvekov proposed a now widely known exponential formula for the coefficient of turbulency:

$$k = k_{\infty}(1 + \varepsilon - e^{-mz/z_1}), \tag{1}$$

where $k_{\infty}(1 + \varepsilon) \approx k_{\infty}$ -- the value of the coefficient of turbulency (k) at a sufficiently great elevation (above the near-surface level); m -- a dimensionless parameter, depending on the thermal stability of the near-surface layer; $\varepsilon = k_0/k_{\infty}$ -- a small dimensionless value equal to the ratio of the values of the coefficients of turbulency at the earth's surface (k_0) and above the earth's surface (k_{∞}); z_1 -- some fixed height.

With instable stratification of the near-surface layer ($Ri < 0$) the change of $\underline{k}$ with height is described by the formula

$$k = k^{*}(e^{pz/z_1} + \varepsilon - 1). \tag{2}$$

By following through, considering various variables and constants, we arrive at a formula for turbulency $\underline{k}$:

$$k = \frac{v_{*}}{a}\left[(1 + al_0)\, e^{xaz} - 1\right]. \tag{26}$$

This formula has the same exponential structure as formulas (1) and (2).

The constants a and l_0 are determined by experimentation.

From a comparison of formulas (2) and (26) we find that when there is instable stratification

$$a = f'(0) = \frac{p}{xz_1} > 0.$$

It should be noted that there is some difference in the structure of empirical formulas (1) and (2) on the one hand and formula (26) on the other. This means that in formula (26) the multiplier before the exponent (in brackets) equals $1 + al_0$, while in (1) and (2) this multiplier is strictly equal to 1. On the other hand the second term in the brackets (26) is equal to -1, while in (1) and (2) it is equal to $-1 + \varepsilon$.

If we substitute the value of $\underline{k}$ determined by formula (26) in ratios (7) and (8)

$$\tau = \rho l^2 \left(\frac{du}{dz}\right)^2 = \rho k \frac{du}{dz}, \qquad (7)$$

$$Q_T = - \quad c_p \rho k \frac{d\theta}{dz}, \qquad (8)$$

and then accomplish integration, taking (12) into account

$$\tau / \rho = \text{const}, \quad Q_T/\rho = \text{const}. \qquad (12)$$

we got the following formulas for the distribution of wind velocity and potential temperature with height in the near-surface layer of the atmosphere:

$$u(z) = \frac{v_*}{x} \ln \frac{1 + al_0 - e^{-xaz}}{al_0}, \qquad (28)$$

$$\theta(z) = \theta_0 - \frac{Q_T}{x\alpha c_p \rho v_*} \ln \frac{1 + al_0 - e^{-xaz}}{al_0}, \qquad (29)$$

where θ_0 -- potential temperature at the earth's surface ($z = 0$). ("Establishment of a Dependence Between the Coefficient of Turbulency and Height in the Near-Surface Layer of the Atmosphere," by L. T. Matveyev, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 83-88).

Electrification of Particles in Clouds and Precipitation

This article gives a quantitative evaluation of possible mechanisms for charging of particles in clouds and precipitation on the basis of experimental data collected at the earth's surface and in the free atmosphere. A comparison of experimental data and the results of computations shows that not one of the known mechanisms can explain the large observed values of charges in rain drops. Rain drops in a cloud can assume large values by means of gravitational coagulation; as the drops fall from a cloud to the earth the value of their charges decreases due to air conductivity. ("Research on Processes of Electrification of Particles in Clouds and Precipitation," by N. V. Krasnogorskaya, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 89-97).

High-Level Acoustical Method of Measurement of Air Temperature

In a previous issue of this Journal (*Izvestiya* Akademii Nauk SSSR, Seriya Geofizicheskaya, No 3, 1959), the author described a local acoustical method for the measurement of air temperature. This method is based on the well known relationship between the speed of sound and temperature. An acoustical thermometer, developed at the Institute of Physics of the Atmosphere of the Academy of Sciences of the USSR, enables us to measure air temperature without errors due to radiation and inertia at altitudes up to 40 km; the influence of wind on acoustical measurements is reduced considerably by the use of two sound receivers.

By comparing the data for temperature recorded by the acoustic thermometer and that transmitted by ordinary radiosondes sent aloft at the same time, we can get information about the correctness of introduced corrections for radiation and other factors. ("Some Results of the Measurement of Air Temperature by the Local Acoustical Method at Altitudes up to 28 Kilometers," by M. I. Mordukhovich, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 96-106).

Influence of the Coriolis Force on Air Turbulency in the Near-Surface Layers

A recently published paper by two workers at the Institute of Physics of the Atmosphere indicates that the Coriolis force leads to a decrease in the values of the coefficient of turbulency in the near-surface layers of the atmosphere, that is, it contributes a stabilizing effect. Their paper, treating of other aspects of turbulency in the lowest layer of the atmosphere, also points out that wind shift in that layer can amount to no more than a few degrees. ("On Turbulent Regime Above the Near-Surface Layer of Air," by A. B. Kazanskiy and A. S. Monin, Izvestiya Akademii Nauk SSSR, No 1, 1960, pp 165-168).

IV. GEOMAGNETISM

Diurnal Variation of Perturbations of Earth Currents

The daily variation of perturbations of earth currents has been investigated by the authors on the basis of data concerning the E-indices of activity; they were derived as the hourly values of the amplitude R of tellurograms (in mv/km). Tellurograms with paper speed of 90 mm/hour were used. The resultant values were averaged individually for each season, for all days:

$$E_i = 1 / n \sum_{n=1}^{n} R_{i,\, n},$$

where n -- the number of days involved in the processing; i -- the number of hours.

TABLE 1

Phases of Maximum of Two First Harmonics S_a of Earth Currents

Latitude F, degrees	λ East Longitude, degrees	Station	Winter 1	Winter 2	Equinox 1	Equinox 2	Summer 1	Summer 2	Coverage of Data in Months (IGY period) Winter	Equinox	Summer
			degrees								
-78	100	Oasis	175	02	195	300	224	47	2	2	2
-77	93	Mirnyy	152	50	185	06	215	05	2	2	2
74	16	Piramida	89	209	110	178	130	207	4	3	2
71	58	Kheys	120	258	146	60	144	180	3	2	4
66	104	Cape Chelyuskin	60	288	105	132	109	202	4	4	4
63	35	Lovozero	25	261	356	250	27	36	4	4	3
60	129	Tiksi			54	150	133	59		2	3
53	39	Borok	323	362	279	60	233	05	4	4	4
49	42	Shatsk	300	348	20	320	60	298	4	4	4
41	34	Alushta	116	23	32	312	81	242	4	2	4
40	142	Yu. Sakhalinsk			134	348				2	
44	158	Petropavlovsk	360	287	108	299	231	186	4	4	4
37	45	Tbilisi	307	339	247	270	243	260	4	4	4
30	58	Ashkhabad	222	323	273	319	223	265	4	4	4
33	77	Alma-Ata	147	301	130	70	127	71	4	4	4

The results of the harmonic analysis of the curves for S_a (diurnal variation of activity) are given in Table 1 and in Figures 1 and 2.

A cosinal form of a Fourier series was used:

$$S_a\,(t) = \sum_{m=0}^{n} r_m \cos\,(mt - \varphi m),$$

where t -- local time.

An analysis of these data made by the authors pursued the limited objective of showing that the diurnal variation of perturbations of earth currents is in agreement with the scheme of presentation of S_a described in [1] (Mishin, V. M., "On the Structure of the Diurnal Variation of Magnetic Activity," <u>Doklady</u>, AS USSR, 118, No 6, 1958).

In accordance with [1], the diurnal variation of magnetic perturbations contains parts controlled by local and universal time:

$$S_a = S'\,(t) + S\,(T).$$

On "disturbed" days the ratios of amplitudes of terms S' (t) and S (T) are close to unity in the middle latitudes and increase to 1.5-2 in the zone of auroras; on "calm" days the ratio is $>$ 2.5 in the middle latitudes and increases still more near latitude 67° [1]. Consequently, the main term of S_a "for all days," whose characteristics are given in Table 1, is the function S' (t). According to [1], this function is satisfactorily described by the first two harmonics of a Fourier series, each of which has the form:

$$S'_1\,(t) = r_1 \cdot \cos\,(t - \varphi 1) = a_1\,(\Phi) \cdot \cos\,(t - \alpha_1) + b_1\,(\Phi) \cdot \cos\,(t - \beta_1), \tag{1}$$

$$S'_2\,(t) = r_2 \cdot \cos\,(2t - \varphi_2) = a_2\,(\Phi) \cdot \cos\,(2t - \alpha_2) + b_2\,(\Phi) \cdot \cos\,(2t - \beta_2). \tag{2}$$

The mean values of $\alpha_1, \alpha_2, \beta_1, \beta_2$ are reckoned in [1] as:

$$\alpha_1 = 215^\circ \quad \beta_1 = 360^\circ \text{ (summer)} \quad \beta_1 = 20^\circ \text{ (winter)}$$

$$\alpha_2 = 340^\circ \quad \beta_2 = 180^\circ$$

The actual values of 1 ... 2 can differ from those cited by $+$ 10-20°. The mean ratios of k (latitude) = b_1/a_1, derived by averaging of data [1] for "disturbed" and "calm" days, are given in Table 2.

TABLE 2

Mean Ratios of k (latitude)

Latitude / Season	30°	40°	50°	60°	65°	70°	75°	80°
Winter	1.0	1.2	2.0	3.2	3.4	2.0	1.2	0.8
Equinox	0.9	1.0	1.75	3.0	2.9	2.7	1.1	0.65
Summer.	0.7	0.8	1.5	2.8	2.3	1.4	1.0	0.5

From (1) it is easy to derive

$$tg\ _1 = \frac{\sin\ _1 + k \sin\ _1}{\cos\ _1 + k \cos\ _1}. \qquad (3)$$

We assumed for winter (Figure 1):

$$_1 = 215^\circ, \quad _1 = 360^\circ,$$
$$_1 = 200^\circ, \quad _1 = 20 \pm 20^\circ. \qquad (4)$$

By means of (3) and (4), using the data in Table 2, we derived curves of dependence of φ_1 (F) on geomagnetic latitude (Figure 1, not reproduced here).

The curves of φ_1 (F) for seasons of the year and the equinoxes were derived in a similar manner. The corresponding values derived for the E-indices of activity of earth currents are plotted as points on the sketches. One can see that the agreement of the observed values for φ_1 and of the curves for φ_1 (F), drawn on the basis of data in [1], is satisfactory.

Figure 2 was drawn for a similar comparison on the basis of data for the second harmonic of S'(t). The agreement of the values of φ_2 with curves found on the basis of appropriate data in [1] is also satisfactory.

Thus, the basic component of the diurnal variation of perturbance of earth currents -- a wave with a diurnal period -- contains two parts with near-noon and near-midnight maxima and amplitudes, varying with latitude [1]. The first of them, in accordance with [1], is associated with the dynamo-effect in the ionosphere, while the second is associated with the screening influence of the ionosphere (in the middle latitudes) and by the nocturnal maximum of conductivity, created by corpuscles intruding into the high latitudes.

It is of interest to note that similar regularities evidently appear in the diurnal variation of frequency of manifestation of k.p.k. (variations of the earth's electromagnetic field with a period from several seconds to a minute).

At a seminar held in May 1959 in the Magnetometry Laboratory of the Institute of Physics of the Earth of the Academy of Sciences of the USSR it was noted, in particular:

a) the amplitudes of k.p.k. have a clear diurnal variation with a maximum around noonday (from a report by a group headed by O. N. Petrova); there is an "effect of the polar night," due to which variations of the type P_c (with a noonday maximum of frequency of appearance) in the polar cap are observed only in local summer (from a report by V. A. Troitskaya);

b) there is a special type of variations with a decreasing period (KUP), which is observed only in the evening and night hours. Presumably this is associated with the screening influence of the ionosphere (from a report by V. A. Troitskaya).

("On the Diurnal Variation of Perturbations of Earth Currents According to Observations of Soviet Stations During the IGY Period," by V. M. Mishin and O. M. Barsukov, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 148-150).

Small Period Variations in the Electromagnetic Field

This article, by two specialists at the Soviet Institute of Physics of the Earth of the Academy of Sciences of the USSR, discusses small period variations in the earth's electromagnetic field, simultaneously appearing at 4 IGY stations in the USSR.

The separating out of variations appearing simultaneously at a number of stations presented certain difficulties, since it was often necessary to detect these variations on a background of others that resembled them in form. They were classified into three groups, A, B, and C, on the basis of clarity. The periods of the investigated variations lay in a range between 1 minute and 20 minutes, with amplitudes varying from some hundredths of a gamma to tens of gammas. Figures 1 and 2 show examples of comparisons of individual types of variations.

The textually and graphically described distribution of the ratios of amplitudes of the constituents of the electromagnetic field, having a rather stable character, is rather difficult to explain at this time. However, stations at which relatively large amplitudes have been recorded are situated on those boundaries of the territory of the USSR which adjoin the seas and oceans. It is possible that electromagnetic disturbances are intensified by the presence of electrical currents in the sea, developing in the coastal zone. Or possibly this is explainable by stable non-homogeneities in the electromagnetic field of the Earth's atmosphere. It is also possible that peculiarities of geological structure exercise an influence on such a distribution. In respect to the origin of simultaneously recorded small-period variations in the geomagnetic field, these are possibly caused by a ring current systems present in the vicinity of the earth at great distances from its surface. Such systems create the more or less homogeneous field in which the Earth is situated. Disturbances in these systems, caused by impacts of corpuscular streams from the Sun, should cause variations in the magnetic field, appearing simultaneously over the entire Earth or on a large part of its surface.

It is also possible that these variations are caused by magnetohydrodynamic waves arising as the result of the penetration of corpuscular streams into the conducting layers of the upper atmosphere and exosphere. ("Small-Period Variations in the Regional Electromagnetic Field," by A. G. Kalashnikov and Ye. N. Mokhova, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 50-54).

V. SEISMOLOGY

Estimation of Earthquake Intensity in China

The fast pace of Socialistic construction in China, about half of which is subject to the influence of destructive earthquakes, requires a constant refinement of the plan for seismic regionalization of that country. At the present time there has been completed the first draft of a plan for the seismic regionalization of the Chinese People's Republic. For a further refinement of the plan we need a rather precise estimation of the seismic activity of the different zones.

If we assume that the potential elastic energy of slow tectonic processes is converted into the kinetic energy of earthquakes, then by considering the total energy of earthquakes of the past in a given region it will be possible to estimate (with appropriate accuracy) the seismotectonic activity of the present. Prolonged observations are necessary for the proper estimation of such activity. In this respect, China, with its ancient culture, is in a relatively favorable position, and information about earthquakes has been collected in that country for almost 3,000 years.

The objective of the present work is the development of a method that in the first approximation will permit us on a sound geophysical basis to estimate seismic activity for the territory of China on the basis of historical data concerning the intensity of earthquakes. For this purpose we have tried to evaluate the energy of earthquake foci from the energy of seismic waves on the basis of the now-adopted M scale. The decrease in the force of the shock or the destructive effect with distance depends on the depth of the focus (Figure 1). Focus II is deeper than focus I and curve II gives a smoother change in intensity. The deeper the focus, the smoother is this decrease. On this are based all the known methods for determining the depth of the focus from macroseismic data.

All other conditions being equal, the intensity of an earthquake is the greater the greater is the energy of the seismic waves emanating from the focus. This relationship is rather complex, but it is possible to establish an empirical relationship between the energy of the seismic waves, the depth of the focus, and the intensity, estimated on the basis of manuscript documents. For checking the correctness of such a conversion, it is possible to use instrumental data for earthquakes of recent years when it is possible to estimate the energy of earthquakes by the M scale and to determine the depth of the focus by differences in the time of arrival of seismic waves.

The density of the emanated energy $\mathcal{E}$ at a distance of Δ and with the depth of the focus h, equal to $E(\Delta, h)$ is proportional to $\frac{\mathcal{E}}{(\sqrt{\Delta^2 + h^2})^{2S'}}$ (where S' is an index depending on conditions of wave propagation). On the other hand, under conditions of harmonic oscillations

$$E(\Delta, h) \sim \frac{A}{T}^2,$$

where A -- amplitude; T -- the period of oscillations. Thus,

$$A / T = n \cdot \frac{\sqrt{\mathcal{E}}}{(\sqrt{\Delta^2 + h^2})^{S'}} \quad \text{(where n -- coefficient)} \qquad (1)$$

From (1) it follows that both velocity and amplitude and acceleration change with distance in accordance with one and the same law.

Determination of intensity from instrumental observations has been made by S. V. Medvedev, who indicates that intensity can be estimated by the amplitude of "forced" oscillations of a pendulum having a period of 0.24 seconds.

Intensity - I	5	6	7	8	9	10
Amplitude - A, mm	05-1	1-2	2-4	4-8	8-16	16-32

Hence, it follows that the relationship between intensity and amplitude is logarithmic, that is, $A = 10^{cI}$, (where c -- some coefficient). Taking (1) into consideration, we get:

$$10^{cI} = m \frac{E}{(\quad^2 + h^2)^{S'}}, \qquad m = nT. \qquad (2)$$

If the intensities I_1 and I_2 were determined at distances $_1$ and $_2$, the logarithm of the ratio of values in (2) gives:

$$I_2 - I_1 = S \lg \frac{{}_1^2 + h^2}{{}_2^2 + h^2}, \qquad S = \frac{S'}{c}. \qquad (3)$$

One should bear in mind that S' is different for different paths of disemination of waves. Thus, with an almost horizontal dissemination of waves S' = 2, in several cases S' = 1 1/2. When there is vertical movement S' should be close to 1. If we have at our disposal a system of data on intensity I_1, I_2, etc., for the mean radii of isoseists $\Delta_1, \Delta_2 \ldots$, then we propose to solve mathematically and simultaneously the problem of determining h and S. For this purpose in the system of coordinates for h and S we draw curves with $S = S(h)$ for the fixed values of I_2, I_1, Δ_1, Δ_2. The point or region of intersection of these curves enables us to simultaneously determine h and S for each earthquake. After determination of the value of S, which appeared quite stable, it was possible to estimate the depth of the foci of past earthquakes, using as a point of departure the intensity at different points, determined from historical data. On this basis it is possible to determine the energy of foci on the M scale as has been done, in particular, in the USSR. It is known that the value M and energy E are related by the equation:

$$E = 10^{\alpha + \beta M}.$$

Substituting E, expressed by M, in (2) and using logarithms, we have:

$$M = aI_0 + b \lg h + d, \qquad (4)$$

where a, b, d -- coefficients.

Let's give the results of research applicable to a series of earthquakes in China.

We processed data for 11 earthquakes in China, beginning in 1918. This enabled us to use the results of observations of seismic stations together with our noninstrumental data.

Data on earthquakes are given in the table, where there are given the dates of earthquakes and the coordinates of their epicenters, derived on the basis of examinations of earthquake traces in the field. The last earthquake in the table was investigated by a special expedition of the Geophysical Institute of the Academy of Sciences of the Chinese Peoples Republic. The last column of the table gives the number of districts or points used for the drawing of isoseists. The intensity M, according to instrumental data for earthquakes 1-10, had been determined earlier, while for earthquake 11, it had been determined at the Geophysical Institute of the Academy of Sciences of the CPR. In only two cases were we able to determine the depth of foci on the basis of data provided by seismic stations. The locations of epicenters are shown in Figure 2 (a map of the distribution of epicenters, not reproduced here).

An example of determination of S, h by the proposed method, is shown in Figure 3 and 4. In all cases the value S proved to be stable, on the average, equal to 5. Its determination in six cases showed that it does not fall outside the range 4.9-5.2.

Using the resulting values for the depth of the foci h, M, and I_0 for 11 earthquakes, we determined the coefficients in formula (4) and as a result received the following dependence:

$$M = 2/3\, I_0 + 4/5 \lg h - 1/2. \qquad (5)$$

The mean errors of the coefficients a and b in (4) proved to be small; the error in determination was on the order of the value itself.

Conclusions

As a result of the work accomplished it proved possible to:

1. Determine the depth of foci in accordance with formula (3), using as a point of departure the mean radii of isoseists, determined from data in historical records; in this case it was established that S = 5 is applicable to China.

2. Determine the values of M, on the basis of formula (4) (after its refinement), using as a point of departure data on the depth of earthquake foci. The results of this work are the first step in current research and in the future some refinements of the derived data may be necessary.

TABLE

No. of Earthquakes	Date	Coordinates of Epicenter		Intensity at Epicenters, I_0	M	h, km	h, Station Data	Districts
1	13. II 1918	23°5'	117	10	7.3	33	--	80
2	16. XII 1920	36 6.	105°7'	12	8.5	50	--	170
3	6 III 1925	25 5	100 3	10	7.1	20	--	10
4	22. V 1927	37 7	102 6	11	8	40	--	12
5	25. XII 1932	39 8	96 9	10	7.6	36	35	7
6	25. VIII 1933	31 8	103 5	10	7.4	45	--	5
7	18. XII 1935	28 8	103 5	8	6	45	--	12
8	7. II 1936	35 5	103 5	8	6.8	54	--	10
9	1. VIII 1936	34 8	106 4	8	6	44	--	16
10	6. IV 1940	23 7	102 4	9	6	15	--	7
11	11. II 1954	39 0	101 5	10	7.2	12	11-20	100 points

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("On the Estimation of the Intensity of Earthquakes in China", by Ye. F. Savarenskiy, Institute of Physics of the Earth of the Academy of Sciences of the USSR and Mei Shih-yung, Academy of Sciences, CPR, Institute of Meteorology and Geophysics, Izvestiya Academii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 135-138).

Seismic Investigation of the Earth's Crust in Central Asia

A number of investigations by the method of deep seismic sounding (GSZ) have been devoted to the study of the structure of the earth's crust in Central Asia. As a result of this work we now have cross-sections of the earth's crust and have drawn isodepth maps for individual regions. Research on the recordings of oscillations caused by powerful explosions has thus far resulted in the drawing of hodographs and the determination of the mean thickness of layers of the earth's crust.

Below are given some results of the processing of the recordings of the powerful explosion of 19 December 1957, set off for scientific purposes by the Academy of Sciences of the USSR at a distance of 100 km to the north of Tashkent. A large number of permanent and temporary seismic stations favorably situated along the transverse profile, enabled the author to draw a cross-section through the earth's crust for a distance of about 1,000 km. To draw this cross-section we used records of 29 seismic stations. The profile I - I, along which our cross-section was drawn, was oriented northeast-southwest and extended from Tadzhik Depression to the northern outliers of the Northern Tien-Shan. As the diagrammatic map in Figure 1 shows, all observation points were situated in a zone about 100 km wide. The resulting cross-section along the Profile I - I therefore characterizes the averaged subsurface relief along this zone. The drawing of the cross-section was accomplished by a method such as described in the literature, using transverse hodographs of P* and P "head" waves, associated with the basalt and Mohorovicic surfaces respectively. We interpreted the arrival of the P^o wave as the arrival of the "head" wave corresponding to the granite layer (the terms "granite" and "basalt" are used conventionally). However, in connection with the fact that at the distance considered (more than 300 km) the P^o wave was very poorly distinguished, we did not draw the boundary of the granite layer. The correlation of the arrivals of elastic waves was made on the basis of an analysis of the kinematic and dynamic peculiarities of the recordings.

The considerable sensitivity of the instruments used (VEGIK seismographs and seismographs of the usual type -- SGK and SVK), the high speed at which the paper moved (120/240 mm/min), and the transmission of data by radio as to the moment of the explosion, enabled us to determine depths to the investigated boundary with an accuracy of $\pm$ 3-5 km.

A more detailed exposition of the method of conducting and processing observations, the estimation of error, the interpretation of the arrivals of elastic waves and the drawing of a cross-section, are given by the author in another work (Ulomov, V. I., Regional Cross-section of the Earth's Crust in Central Asia and the Thickness of Alluvial Material in the Tashkent Area, Izvestiya of the Academy of Sciences of the Uzbek, SSR, Physics-Mathematics Series).

The data for the depth to the basalt and Mohorovicic surfaces, determined for each point of observation, were corrected for seismic drift and projected on a vertical plane along the profile I - I. As was shown by a preliminary compilation of the isodepth map to the discontinuity in the earth's crust noted in Figure 2, the scattering in the data for depth is basically explained by projection of areas with a quite complex relief on a vertical plane.

As can be seen from the resulting cross-section (Figure 2a), within the limits of the examined region there is an unconformity in the stratification of the basalt and Mohorovicic surfaces. The Mohorovicic boundary for the entire length of the cross-section is relatively static, situated at a depth on the order of 50 km, and only in the region of the Northern Tien-Shan is there a considerable rise, with an amplitude on the order of 10-15 km. The configuration of the Mohorovicic surface at the northern end of the profile is unclear due to weak arrivals of P waves in this region. The depth of occurrence of the basalt varies in wide limits. The maximum thickness (about 40 km) of basalt is in the region of juncture between the Southern Tien-Shan and the Fergana Depression, the least (about 10 km) -- in the region of the Tadzhik Depression.

There is no doubt that the relief of both boundaries was smoothed out for the entire length of the profile and in places was drawn inaccurately due to the great distances between the points of observation.

For a comparison of the resulting cross-section with the results of work on deep seismic sounding of the earth's crust in Figure 2b there are three deep seismic sounding profiles shown: a cross-section along the meridian of 72°30' (1) and cross-sections running from Issyk-kul'-Frunze-Chankuduk (2) and Issyk-kul'-Teskensu-Balkhash (3) (corresponding to profiles a-a, b-b and c-c in Figure 1). All these deep seismic sounding profiles were situated at some angle to the profile I - I.

By comparing these cross-sections with adjacent parts of the cross-section along the profile I - I, we can find good agreement between our results and the results of deep seismic sounding. In particular, in cross-section 1 (Figure 2b) there is a noticeable thickening of the basalt layer in the northern part of the Pamir-Alay zone, in the direction of the Fergana Depression.

 CPYRGHT

For comparison of the derived results with gravimetric data for the examined cross-section there is given the observed curve for Δg in the Bouguer reduction, drawn on the basis of results derived by the Scientific Research Institute of Geophysical Reconnaissance of the Ministry of the Petroleum Industry of the USSR. The curve for the gravimetric anomaly was averaged for area, taking the values for seismic drift into consideration.

As is well known, the configuration of curves for Δg depends on the composite influence of the basalt and Mohorovicic surfaces. The direct problem of gravimetry was solved for the purpose of clarifying the connection between the configuration of the curve for Δg and the deep structure of the studied region. Computations were made using G. A. Gamburtsev's overlay for determination of the value of Δg in the case of a two-dimensional problem. It should be noted that the accomplished averaging over some area of the depths to the investigated boundaries was made by the valid solution of a two-dimensional problem even for those parts of the region in which isoanomalies were situated at some angle to the direction I - I. A map of gravitational anomalies of Central Asia in the Bouguer reduction is given in work /10/ (Rosova, Ye. A., Location of the Epicenters and Hipocenters of Earthquakes in Central Asia, Works of the Geophysical Institute of the Academy of Sciences of the USSR, No 10 (137), 1950). In Figure 2 the dotted lines show the computed curves drawn for densities $P_1 = 2.7$, $P_2 = 2.8$ and $P_3 = 3.4$ g/cm^3, which corresponds to differences in density of $\Delta P_1 = 0.1$ and $\Delta P_2 = 0.6$ g/cm^3. These values do not exceed the limits of the values of densities given in the literature for rocks making up the principal strata of the earth's crust.

Besides the computed differential Δg curves for the basalt and Mohorovicic surfaces, Figure 2 gives a curve for a gravitational anomaly associated with the top of the Paleozoic basement in the southern part of the Fergana Valley (between Fergana and Andizhan). In connection with the presence in this region of a considerable sedimentary stratum it is necessary to take into account the gravitational effect caused by the stratum of alluvium. The curve was drawn by computations made in the Geophysical Section of the Central Asiatic Institute of Geology and Mineral Raw Materials, taking into account changes with depth in the density of the covering sand-clay stratum. In this same region the cross-section shows the surface of the Paleozoic basement, corresponding to the computed gravitational anomaly.

As can be seen from Figure 2, the composite gravitational curve, with the exception of deviations in the region of the Central and Northern Tien-Shan, coincides, completely with observations. Ruggedness of the basalt and Mohorovicic surfaces in the region of the Northern Tien-Shan, also well noted in cross-section three of the deep seismic sounding series (Figure 2b) and on our cross-section as well, did not show the expected decrease in negative gravitational anomaly. Such a phenomenon, evidently, can be explained in the first approximation only by a decrease in the density of the earth's crust in this region (hypothetically due to the presence of deep-seated zones of dislocation). By varying density in the boundary, for example, from 2.7 to 2.55 g/cm^3, it is possible to achieve a complete coincidence of observed and computed curves in this region.

Thus, as computations have shown, an increase in the negative gravitational anomaly in the northern part of the profile is evidently associated with a subsidence of the basalt and Mohorovicic boundaries. The minimum gravitational anomaly in the region of juncture between the Fergana Depression and the Southern Tien-Shan is associated with a thickening of the basalt layer. Finally, a large negative gravitational anomaly corresponds to the deep structure of the Southern Tien-Shan and the Tadzhik Depression (decrease in the thickness of basalt.)

In conclusion, I express gratitude to Ye. M. Butovskaya for the seismograms of the powerful explosions and for the valuable advice given.
("Some Peculiarities of the Structure of the Earth's Crust in Central Asia, Based on Recordings Made of a Powerful Explosion," by V. I. Ulomov, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 131-134).

Convection in the Earth's Mantle

Many researchers (especially abroad) support the hypothesis that heat convection in the Earth's mantle is the fundamental cause for geotectonic processes. For an evaluation of this hypothesis it is useful to find out what percentage of the energy of a convective current can be transmitted to the crust. This article endeavors to give an approximate answer to that question.

Solution of the problem begins with a study of the transfer of laminar flow energy to a movable wall. The assumption is made that the space between two unlimited plane-parallel inclined walls is filled with an incomressible fluid flowing under the influence of its own weight. One of the walls (the upper) moves evenly in the direction of flow (the distance between the walls does not change.) We need to find the maximum percentage of the energy of the current which can be transferred to the moving wall. Use of a series of formulae will first solve the problem for a case where both walls are fixed, and then for a case with an infinitely thin moving wall, where we find the full energy developed by the current and the part of this energy transmitted to the moving wall. Further variables can be introduced. This has applicability when we study convection in the earth's mantle.

Convection in the earth's mantle must occur in the form of brief cataclysms, separated by long periods of rest. In the course of these periods a considerable difference in temperature can develop. Assuming the thickness of the mantle to be $3 \cdot 10^3$ km., the adiabatic temperature gradient to be 0.3 degrees/km, the superadiabatic difference to be 1,000° and the subcrustal temperature to be 1,500° K., we find that the upper limit for the thermodynamic coefficient of efficiency in the mantle itself is about 60%.

It appears that less than 6% of the total energy of heat sources feeding convection can be transferred to the crust.

If the hypothesis of convection is true, the heat flow feeding convection must constitute a large part of the current of heat coming from the depths of the Earth. Assuming this to be 10^{28} ergs/year, we get the upper limit of energy which can be used for tectonic processes in the crust, about 10^{26} erg/year. The energy of present-day seismic waves of shallow earthquakes is approximately 10^{25} erg/year. These figures do not necessarily contradict one another. However, under such circumstances the periods of rest would be too long (tens of millions of years). It is more probable that current tectonic activity is associated with gravitational differentiations in the upper part of the earth's crust. Having lost its light components, this layer becomes heavier than the geosphere below and it moves downward; this can give rise to a convection that is more powerful than thermal convection. The active periods of such "geochemical" convection may be associated with very great tectonic cataclysms. ("Convection in the Earth's Mantle," by Ye. N. Lyustikh, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 3-5).

Seismic Research Near Alma-Ata

In the period 1951-1953 a series of experiments was made for recording of earthquakes with azimuthal apparatus. Such experiments were made in Turkmenia in 1951, near Alma-Ata in 1952, and in the Garma Oblast in 1953.

The azimuthal apparatus records components of soil displacement in different directions. This makes it possible to determine the vector of soil displacement. In the case of a longitudinal wave the direction of this vector coincides with the direction of a ray arriving at the station with the first appearance of the longitudinal wave.

An effort is made here to expand this method to subsequent appearances of the wave and define several other types of waves.

Seismograms of local earthquakes were used for this purpose. In data processing the recordings of a large number of earthquakes were used -- about 100.

The data used came from the Garma Expedition of the Geophysical Institute of the Academy of Sciences of the USSR in 1953. Over a period of 3.5 months local earthquakes were recorded by two azimuthal stations, KMIZ-I and KMIZ-II. Epicenters were determined with the assistance of mobile stations, working jointly with the KMIZ stations.

The azimuthal apparatus used each consisted of 8 seismographs, oriented in different directions and tilted 45°.

The author proceeds to an interpretation of the recordings. Twelve figures supplement the text in describing the processing method used.

Data from the station KMIZ-I showed the existence of a deep discontinuity at a depth of 32-36 km; the station KMIZ-II showed it to lie at 38-40 km. The mean velocity in all the covering medium varied between about 5-7 km/sec. In addition there also exists a reflecting layer, situated at a distance of 20 km, and the mean velocity in its covering medium also varies between 5 and 7 km/sec. ("On Exchange and Reflected Waves on Azimuthal Seismograms of Earthquakes in the Garma Oblast," by Ye. V. Glivenko, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 126-130).

VI. OCEANOGRAPHY

First Cruise of the "Weather Ship"

The following is the complete text of a news dispatch from Vladivostok, appearing in the 25 February 1960 issue of "Pravda":

Yesterday the expeditionary ship "A. Voyeykov" of the Hydrometeorological Service returned to port after 45 days work in the Pacific Ocean.

On arrival at the point of observation in the middle part of the ocean, the ship found itself in a zone of a severe storm, up to 12 on the Beaufort scale. The storm was accompanied by snow. The listing of the ship at times was up to 45°. The ship became ice-covered and the entire crew and participants in the expedition answered an alarm for the removal of ice. The expedition conducted round-the-clock observations despite the exceptionally difficult conditions experienced on the voyage.

The ship then moved to more southerly regions of the tropical zone. Moving along 178° East Longitude, the "A. Voyeykov" made a cross section from 45° to 8° North Latitude. Twenty five meteorological rockets were sent aloft during the course of the cruise. Aerologists sent more than 100 radiosondes aloft. Jet streams were discovered at an altitude of about 9 km, with wind velocities greater than 200 km/hour.

The first cruise of the "weather ship" marked the beginning of regular atmospheric research over the Pacific Ocean. ("First Cruise of the 'Weather Ship'," Unsigned dispatch, Pravda, 25 February 1960, p 4).

The Quasistationary Nature of Drift Currents in the Ocean

V. M. Kamenkovich, of the Institute of Oceanology of the Academy of Sciences of the USSR, whose paper in the Doklady of the Academy of Sciences, No 6, 1958, dealt with the equations applicable to the dynamics of stationary currents, has now published a paper dealing with his mathematical analysis of quasistationary drift currents in the ocean. ("On the Quasistationary Nature of Drift Currents in the Ocean, by V. M. Kamenkovich, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 74-82).

VII. ARCTIC AND ANTARCTIC

Recent News of Arctic Activities

In the second half of March the Arctic and Antarctic Scientific Research Institute will send still another expedition to the Arctic. It will establish 15 automatic radio meteorological stations on drift ice in the Leptev, Kara, East Siberian and Chukchee Seas.

B. Kremer, Chief of the Scientific Section of the Main Administration of the North Sea Route, in reviewing work in the Arctic during the last six years, points out that the "Severnyy Polyus" scientific stations have drifted a total of more than 28,000 km. About 55,000 meteorological and actinometric observations have been made at the drift stations, more than 10,500 radiosondes and pilot balloons have been sent aloft, and the depth of the Arctic Ocean has been measured at almost 7,000 points.

The present station, "SP-8", commanded by V. Rogachev, was organized in April of last year by the expedition "Sever-11", commanded by M. Nikitin, a participant in all high latitude expeditions since 1948. Although the actual route followed by the drift station was 2,360 km, it moved only 380 km in straight course, becase it followed a highly tortuous route.

In regards to the research program of the drift stations in 1960-1961, the expedition "Sever-12", will relieve the personnel at the station "SP-8" and organize still another drift station, the "Severnyy Polyus-9". M. Nikitin, Candidate in Geographical Sciences, will again head operations.

The new station is to be organized to the northeast of the New Siberian Islands, approximately in the area of 79-81° N. and 140-160° E. All types of work previously accomplished on the "SP-8" will be continued at that station. The same types of work will be accomplished on the "SP-9", with the exception of geophysical research. The two drift stations will be headed by the young but experience oceanographers N. Vlinov and V. Shamont'yev.

The expeditions and drift stations are supplied with the latest apparatus and instruments. Life for the polar specialists will be a little easier; they will now have electric stoves for cooking and central water heating for the huts, supplied from the diesel generators of the power plant.

The expedition will be supported by an aviation detachment under the command of the well-known polar flier P. Moskalenko. ("To the High Latitudes Again", by O. Stroganov, Moscow, Izvestiya, 28 February 1960, p 3)

Atmospheric Circulation in Northern and Southern Hemispheres Contrasted

G. V. Gruza, of the Central Asiatic Hydrometeorological Scientific Research Institute, reports the following comparisons of circulation of the atmosphere in the Northern and Southern Hemispheres on the basis of data collected at the Mirnyy observatory during the work of the Third Soviet Complex Antarctic Expedition in 1958.

The data used and analyzed give reason to believe that in respect to the atmosphere the cooling role of the Antarctic region is greater than that of the Arctic. These data are nevertheless inadequate to solve the problem of the role of the polar regions in the heat balance of the atmosphere, because the heat is carried into the Arctic region from the low latitudes by air and sea currents whereas heat is carried into Antarctica by the atmosphere alone. The presence of a relatively warm mass of water under the ice of the Arctic is one of the important factors making its climate less severe than that of Antarctica. The heat loss from the active surface in the Arctic by radiation is probably less than in Antarctica because the air layer over Antarctica is less thick and less humid. These facts probably explain the greater temperature contrasts and greater intensity of zonal circulation in the Southern Hemisphere.

The results set forth in this paper indicate the expediency of a further study of peculiarities of atmospheric planetary movements and the particular importance of the comparative study of atmospheric processes in the Northern and Southern Hemispheres. ("On Certain Zonal Peculiarities in the General Circulation of the Atmosphere," by G. V. Gruza, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 161-164).

Characteristics of Stratus and Stratocumulus Clouds and Fogs in the Arctic

In the summer of 1956 an expedition visited the Central Arctic to study the microphysical structure of clouds and fogs observed there in the summertime. Such work had not been accomplished at any time earlier.

This article gives the results of measurements of the water content of stratus cloud forms as well as the humidity, temperature, transparency and spectrum of drops in such clouds.

Vertical soundings were made in clouds of types St and Sc and in fogs for the measurement of meteorological elements at each 20-50-100 m height, and some horizontal soundings of frontal cloudiness were made. Many flights were made over the Kara Sea for this purpose.

This article describes the instruments used and the accuracy with which measurements were made. Drops were microphotographed by methods previously described in the literature. A new photoelectric instrument, the SIP-3, was used for measurement of cloud transparency. This instrument is described in some detail, probably for the first time in the literature. Figure 1 is a diagrammatic sketch of this instrument. The SIP-3 measures the meteorological range of visibility in the range of 26-500 m with an error not exceeding 20%, provided the geometric length of the base is 13 m.

All observed Arctic fogs were situated under inversions or isothermal layers. Their vertical thickness was from 40 to 230 m., most commonly between 100-160 m.

Sounding in fogs was accomplished in aircraft for the first time in 1956. The mean water content varied from 0.08 - 0.2 g/m^3. Maximum water content occurs in the upper third of the fog layer, although when the air was isothermally stratified the water content varied but little with height. (Figure 2, not reproduced here, is a graph showing the vertical distribution of water content and the meteorological range of visibility in a fog). The mean range of visibility in fog is 60-120 m. The maximum visibility (180 m) is in the lower part of the fog, while the minimum (30-40 m) is in its upper part, at the very upper edge of the top layer.

Vertical soundings were made of stratus clouds, most of which were supercooled clouds at temperatures between 0 and 10°. The mean water content in stratus clouds was 0.05-0.2 g/m^3, with maximum values in the upper third of the cloud.

The Sc clouds differed from St clouds in a number of ways. St clouds are formed at greater heights than Sc clouds. St clouds sometimes extend down to the earth's surface, but Sc are not observed below 300 m; St clouds are from 50-700 m thick, whereas Sc clouds range between 150-600 m thick; in most cases there was not the same characteristic distribution curves of drop size in Sc as in St, the maximum radius of drops in Sc sometimes exceeded 100-200 μ, whereas in St it was 50-100 μ.

Figure 4 is a graph showing the vertical distribution of water content, range of visibility and temperature in a stratus cloud. Figure 5 shows the vertical distribution of water content, visibility, and effective size of drops in a cirrostratus cloud. Figure 6 shows the temperature stratification and vertical distribution of water content and visibility in a stratocumulus cloud. ("Experiment in the Complex Investigation of St and Sc Clouds and Fogs in the Arctic," by A. L. Dergach, G. M. Zabrodskiy, and V. G. Morachevskiy, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 1, 1960, pp 107-114).

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